

THE CLAIMS

What is claimed is:

1. An aqueous-based removal composition useful for removing photoresist, bottom anti-reflective coating (BARC) materials, and/or gap fill materials from a substrate having such material(s) thereon, said composition comprising a fluoride source, at least one organic amine, at least one organic solvent, water, optionally at least one chelating agent, and optionally at least one surfactant.
2. The composition of claim 1, comprising the following components based on total weight of the composition:

0.1 % wt. – 15.0 % wt. fluoride source;

20.0 % wt. - 60.0 % wt. total organic amine;

1.0 % wt. – 60.0 % wt. total organic solvent;

20.0 % wt. – 70.0 % wt. water;

optionally 0.000 % wt. – 20.0 % wt. chelating agent; and

optionally 0.000 % wt. – 5.0 % wt. surfactant,

wherein the total of the weight percentages of such components of the composition does not exceed 100 % by weight.
3. The composition of claim 2, wherein the fluoride source comprises a fluoride-containing compound selected from the group consisting of ammonium fluoride,

hydrogen fluoride, ammonium bifluoride, tetraalkylammonium difluoride, alkyl phosphonium difluoride, and triethylamine trihydrofluoride.

4. The composition of claim 2, wherein the fluoride source comprises ammonium fluoride.
5. The composition of claim 2, wherein the at least one organic amine comprises an amine-containing compound selected from the group consisting of hydroxyethylpiperazine, hydroxypropylpiperazine, aminoethylpiperazine, aminopropylpiperazine, hydroxyethylmorpholine, hydroxypropylmorpholine, aminoethylmorpholine, aminopropylmorpholine, triethanolamine, pentamethyldiethylenetriamine, dimethylaminoethoxyethanol, aminoethoxyethanol, ethylene urea, trimethylaminoethylethanolamine, trimethylaminopropylethanolamine, N-(2-cyanoethyl) ethylenediamine, and N-(2-cyanopropyl) ethylenediamine.
6. The composition of claim 2, wherein the at least one organic amine comprises an amine-containing compound selected from the group consisting of hydroxyethylmorpholine and N-(2-cyanoethyl) ethylenediamine.
7. The composition of claim 2, wherein the at least one organic solvent comprises a compound selected from the group consisting of 1,4-butanediol, 1,3-butanediol, ethylene glycol, propylene glycol, N-methyl-2-pyrrolidone, DMSO, r-butyrolactone, propylene glycol monomethyl ether, propylene glycol monomethyl ether acetate, diethyleneglycol monobenzylether, ethyl lactate, ammonium lactate, and dimethyl acetamide.

8. The composition of claim 2, wherein the at least one organic solvent comprises propylene glycol monomethyl ether.
9. The composition of claim 2, comprising chelating agent.
10. The composition of claim 9, wherein the chelating agent comprises a compound selected from the group consisting of iminodiacetic acid, boric acid, ammonium borate, ammonium tetraborate, gluconic acid, mannitol, and sorbitol.
11. The composition of claim 2, comprising surfactant.
12. The composition of claim 11, wherein the surfactant comprises a compound selected from the group consisting of: (C₁-C₁₅) alkyl glucosides; (C₁-C₁₅) alkyl ethylene oxide/propylene oxide; (C₁-C₁₀) alkyl phenoxy ethylene oxide/propylene oxide; and oxirane, methyl-, polymer with oxirane, ether with 2, 2'-(oxidoimino)bis(ethanol) (2:1) and N(-3-(C(-11-isoalkyloxy)propyl) derivatives.
13. The composition of claim 11, wherein the surfactant comprises a compound selected from the group consisting of decyl glucoside, AO-405, AO-455, CA-520, CO-630, CA-720 and CO-890, CO-210, CO-520, CO-990 and DM-970.
14. The composition of claim 11, wherein the surfactant comprises decyl glucoside.
15. The composition of claim 2, selected from the group consisting of Formulations A-E, wherein all percentages are by weight, based on total weight of the formulation:

Formulation A

about 8 % NH_4/HF ;
about 30 % hydroxyethylmorpholine;
about 7 % N-(2-cyanoethyl) ethylenediamine;
about 15 % propylene glycol monomethyl ether;
about 40 % de-ionized water; and
about 0.05 % decyl glucoside;

Formulation B

about 8 % NH_4/HF ;
about 30 % hydroxyethylmorpholine;
about 7 % N-(2-cyanoethyl) ethylenediamine;
about 25 % propylene glycol monomethyl ether; and
about 30 % de-ionized water;

Formulation C

about 8 % NH_4/HF ;
about 30 % hydroxyethylmorpholine;
about 7 % N-(2-cyanoethyl) ethylenediamine;
about 24 % propylene glycol monomethyl ether;
about 30 % de-ionized water; and
about 1 % ammonium tetraborate;

Formulation D

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 15 % propylene glycol monomethyl ether;

about 40 % de-ionized water; and

about 0.10 % alkyl EOPO amine oxide surfactant;

Formulation E

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 15 % propylene glycol monomethyl ether;

about 40 % de-ionized water; and

about 0.10 % EO octylphenol surfactant; and

Formulation F

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 15 % propylene glycol monomethyl ether;

about 40 % de-ionized water; and

about 0.10 % EO nonylphenol surfactant;

wherein the total of the weight percentages of such components of the composition does not exceed 100 % by weight.

16. The composition of claim 11, comprising the following components, based on total weight of the composition:

5.0 % wt. – 10.0 % wt. fluoride source;

35.0 % wt. - 40.0 % wt. total organic amine;

10.0 % wt. – 30.0 % wt. total organic solvent;

25.0 % wt. – 45.0 % wt. water; and

0.05 % wt. – 0.10 % wt. surfactant,

wherein the total of the weight percentages of such components of the composition does not exceed 100 % by weight.

17. The composition of claim 2, wherein the pH of the composition is in a range from about 5 to about 9.
18. A method of removing photoresist, BARC material, and/or gap fill material from a substrate having said material(s) thereon, said method comprising contacting the substrate with an aqueous-based removal composition for sufficient time to at least partially remove said material from the substrate, wherein the aqueous-based removal composition includes a fluoride source, at least one organic amine, at least

one organic solvent, water, optionally at least one chelating agent, and optionally at least one surfactant.

19. The method of claim 18, comprising the following components based on total weight of the composition:

0.1 % wt. – 15.0 % wt. fluoride source;

20.0 % wt. - 60.0 % wt. total organic amine;

1.0 % wt. – 60.0 % wt. total organic solvent;

20.0 % wt. – 70.0 % wt. water;

optionally 0.000 % wt. – 20.0 % wt. chelating agent; and

optionally 0.000 % wt. – 5.0 % wt. surfactant,

wherein the total of the weight percentages of such components of the composition does not exceed 100 % by weight.

20. The method of claim 18, wherein the substrate comprises a semiconductor device structure.
21. The method of claim 18, wherein the material comprises photoresist.
22. The method of claim 18, wherein the material comprises BARC material.
23. The method of claim 22, wherein the BARC material has been applied to a semiconductor device structure to minimize reflectivity variations during photolithographic patterning on the semiconductor device structure.

24. The method of claim 18, wherein the material comprises gap fill material.
25. The method of claim 18, wherein said contacting is carried out for a time of from about 1 minute to about 5 minutes.
26. The method of claim 18, wherein said contacting is carried out at temperature in a range of from about 20°C to about 40°C.
27. The method of claim 19, wherein the fluoride source comprises a fluoride-containing compound selected from the group consisting of ammonium fluoride, hydrogen fluoride, ammonium bifluoride, tetraalkylammonium difluoride, alkyl phosphonium difluoride, and triethylamine trihydrofluoride.
28. The method of claim 19, wherein the fluoride source comprises ammonium fluoride.
29. The method of claim 19, wherein the at least one organic amine comprises an amine-containing compound selected from the group consisting of hydroxyethylpiperazine, hydroxypropylpiperazine, aminoethylpiperazine, aminopropylpiperazine, hydroxyethylmorpholine, hydroxypropylmorpholine, aminoethylmorpholine, aminopropylmorpholine, triethanolamine, pentamethyldiethylenetriamine, dimethylaminoethoxyethanol, aminoethoxyethanol, ethylene urea, trimethylaminoethylethanolamine, trimethylaminopropylethanolamine, N-(2-cyanoethyl) ethylenediamine, and N-(2-cyanopropyl) ethylenediamine.
30. The method of claim 19, wherein the at least one organic amine comprises an amine-containing compound selected from the group consisting of hydroxyethylmorpholine and N-(2-cyanoethyl) ethylenediamine.

31. The method of claim 19, wherein the at least one organic solvent comprises a compound selected from the group consisting of 1,4-butanediol, 1,3-butanediol, ethylene glycol, propylene glycol, N-methyl-2-pyrrolidone, DMSO, r-butyrolactone, propylene glycol monomethyl ether, propylene glycol monomethyl ether acetate, diethyleneglycol monobenzylether, ethyl lactate, ammonium lactate, and dimethyl acetamide.
32. The method of claim 19, wherein the at least one organic solvent comprises propylene glycol monomethyl ether.
33. The method of claim 19, comprising chelating agent.
34. The method of claim 33, wherein the chelating agent comprises a compound selected from the group consisting of iminodiacetic acid, boric acid, ammonium borate, ammonium tetraborate, gluconic acid, mannitol, and sorbitol.
35. The method of claim 19, comprising surfactant.
36. The method of claim 35, wherein the surfactant comprises a compound selected from the group consisting of: (C₁-C₁₅) alkyl glucosides; (C₁-C₁₅) alkyl ethylene oxide/propylene oxide; (C₁-C₁₀) alkyl phenoxy ethylene oxide/propylene oxide; and oxirane, methyl-, polymer with oxirane, ether with 2, 2'-(oxidoimino)bis(ethanol) (2:1) and N(-3-(C(-11-isoalkyloxy)propyl) derivatives.
37. The method of claim 35, wherein the surfactant comprises a compound selected from the group consisting of decyl glucoside, AO-405, AO-455, CA-520, CO-630, CA-720 and CO-890, CO-210, CO-520, CO-990 and DM-970.

38. The method of claim 35, wherein the surfactant comprises decyl glucoside.
39. The method of claim 19, selected from the group consisting of Formulations A-E, wherein all percentages are by weight, based on total weight of the formulation:

Formulation A

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 15 % propylene glycol monomethyl ether;

about 40 % de-ionized water; and

about 0.05 % decyl glucoside;

Formulation B

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 25 % propylene glycol monomethyl ether; and

about 30 % de-ionized water;

Formulation C

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 24 % propylene glycol monomethyl ether;

about 30 % de-ionized water; and

about 1 % ammonium tetraborate;

Formulation D

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 15 % propylene glycol monomethyl ether;

about 40 % de-ionized water; and

about 0.10 % alkyl EOPO amine oxide surfactant;

Formulation E

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 15 % propylene glycol monomethyl ether;

about 40 % de-ionized water; and

about 0.10 % EO octylphenol surfactant; and

Formulation F

about 8 % NH_4/HF ;

about 30 % hydroxyethylmorpholine;

about 7 % N-(2-cyanoethyl) ethylenediamine;

about 15 % propylene glycol monomethyl ether;

about 40 % de-ionized water; and

about 0.10 % EO nonylphenol surfactant;

wherein the total of the weight percentages of such components of the composition does not exceed 100 % by weight.

40. The method of claim 35, comprising the following components, based on total weight of the composition:

5.0 % wt. – 10.0 % wt. fluoride source;

35.0 % wt. - 40.0 % wt. total organic amine;

10.0 % wt. – 30.0 % wt. total organic solvent;

25.0 % wt. – 45.0 % wt. water; and

0.05 % wt. – 0.10 % wt. surfactant,

wherein the total of the weight percentages of such components of the composition does not exceed 100 % by weight.

41. The method of claim 19, wherein the pH of the composition is in a range from about 5 to about 9.

42. The method of claim 18, further comprising contacting the substrate with deionized water following contact with the aqueous-based removal composition.
43. The method of claim 18, further comprising inspecting the substrate by optical microscopy and determining therefrom the removal efficiency of the aqueous-based removal composition.